Partial translation of JP-A H05-020563 (Reference 1)

[0012]
EMODIMENTS

Fig. 1 is a diagram of a first embodiment of the invention. In Fig. 1, reference numeral 10 is a high sensitivity camera, such as a CCD color camera or a color video camera. The camera 10 has an auto-focus device 14 for automatic focus control on an object. It is set at a location, such as a higher portion on a wall of the room, where a monitoring region such as a room can be looked over.

[0013] A light emitter 14 having a light-emitting device such as a light-emitting diode is set at a position opposing to the camera 10. A synchronizer 16 controls the high sensitivity camera 10 and the light emitter 14 at each image sampling period in synchronization with imaging operation. Thus, if smoke is present in the monitoring space 50, when the camera 10 captures a monitoring space 50, it captures the smoke 100 under backlight illumination by the emission of the light emitter 14 in synchronization with the imaging operation by the synchronizer 16.

[0014] In image signals recorded by the camera 10 such as NTSC image signals, the brightness signals are converted to multi-level digital signals for each sampling period by an analog-to-digital converter 18 and stored alternately in a first frame memory 20A and in a second frame memory 20B. Thus, two image data sequential in time are stored in the first and second frame memories 20A, 20B as multi-level pixel signals for pixels.

[0015] A smoke area detector 22 is provided after the first and second frame memories 20A, 20B. It detects a smoke area in the screen information under processing. In the detection of a smoke area, the multi-level pixel signals in a current screen and in a previous screen stored in the first and second frame memories 20A, 20B are compared for each pixel, and if the pixel signal of a pixel in the current screen becomes smaller by a predetermined level or more than the counterpart in the previous screen, and the positions of such pixels are concentrated and the number of such pixels is larger than a predetermined number, the area satisfying the conditions is detected as a smoke area.

[0016] Information on the smoke area detected by the smoke area detector 22 is sent to a smoke density calculator 24. The calculator 24 reads the multi-level pixel signals in the smoke area in the screen stored, for example, in the first frame memory 20A and converts them to smoke density signals for relevant pixels. Fig. 2 shows a graph on a relationship of smoke density plotted against multi-

level pixel signal, used for calculation in the smoke density calculator 24.

[0017] In Fig. 2, the multi-level pixel signal is normalized in the axis of abscissa as 1.0 at smoke density of 0 [%/m]. The smoke density increases with decreasing multi-level signal. Turning to Fig. 1, the density signal for each multi-level signal calculated by the smoke density calculator 23 is stored in the first or second smoke area frame memories 26A and 26B. In this embodiment, the two frame memories 26A and 26B are provided because density signals in the current screen and those in the previous screen are necessary.

[0018] A smoke quantity integrator 28 is provided after the first and second smoke area frame memories 26A and 26B. The smoke quantity integrator 28 calculates the smoke quantity in the smoke area by reading and integrating density signals included in the smoke area in the current screen stored in one of the first and second smoke area frame memories 26A, 26B. On the other hand, an amount-of-change integrator 30 calculates a difference of smoke quantity between the current and previous screens. It subtracts for each pixel the density signal in the previous screen from that in the current screen and integrates the difference to create a time change in smoke density.

[0019] The smoke quantity calculated by the smoke quantity integrator 28 and the time change in smoke quantity calculated by the amount-of-change integrator 30 are sent to a fire detector 32 to determine whether a fire is present or not. The fire detector 32 has a first detecting section 34 to determine fire breaking based on the smoke quantity and a second detection section 36 to determine fire breaking based on the amount of change in smoke quantity. In the detection of fire breaking in the first detection section 34, for example, two threshold values are predetermined, and it is decided that a fire breaks for a value larger than the larger threshold value. However, for a value between the two threshold values, the first detection section 34 asks the second detection section 36 to decide fire breaking based on the amount of change in smoke density. In the second detection section 36, fire breaking is decided based on the time change in smoke quantity exceeding the lower threshold value. For example, it is decided that a fire breaks when the smoke quantity increases more than the previous value and the amount of change is larger than a threshold value.

[0020] In the detection of fire breaking based on the smoke quantity and the time change thereof, besides the above-mentioned comparison with use of fixed threshold values, the change in smoke quantity in the future may be predicted according to the time change in the past. Further, in the embodiment shown in Fig. 1, a distance detector 40 is provided. In this embodiment, the distance to the smoke 100 is detected by considering the information of moving distance of lens

in the focusing state for the smoke 100 by the auto-focus device 12 of the camera 10.

[0021] The distance information to the smoke 100 obtained by the distance detector 40 is sent to the smoke density calculator 24, and the size of the detected smoke area is corrected because the size changes in the screen according to the distance. For example, it is assumed that the detected smoke area observed from the standard distance L is S and the area observed from twice the distance 2L is S/2. In this case, in order to correct the detected smoke area S/2 in the screen observed at the distance 2L to the size for the standard distance L, the area is changed to (S/2)*2, and the density signal is obtained for each pixel in the corrected smoke area.

[0022] Because the detected smoke area S is represented as the number of pixels, it is troublesome to correct the distance in the unit of pixel due to thinning of data and interpolation of distance. Then, in the actual processing, a correction coefficient is obtained in the smoke density calculator 24 based on the standard distance and the detected distance and is sent to the smoke quantity integrator 28 and the amount-of-change integrator 30, besides the density signals, to multiply the integrated value with the correction coefficient according to the distance.

[0023] Fig. 3 shows a diagram of a second embodiment of the invention, and this embodiment has a feature that an area to be calculated on the smoke density is fixed relative to the imaging screen. In the embodiment shown in Fig. 3, an area mask setter 42 is provided instead of the smoke area detector 22. As shown in Fig 4(a), the area mask setter 42 sets a mask 60 having predetermined shape and size at a predetermined position in the imaging screen. Preferably, a slit-like mask is used as the mask 60 extending around the center of the screen along an almost entire portion in the lateral direction because smoke rises from bottom due to hot airflow on fire.

[0024] The area mask setter 42 sets an area to be calculated on the smoke quantity at the predetermined position in the screen, as shown in Fig 4(a). At the same time, it performs a feedback control to set the mask at the center of the rising smoke 100, as shown in Fig. 4(b), by using a vertical rotation mechanism 46 and a horizontal rotation mechanism 48 for the camera 10 driven by a camera scanner 44.

[0025] By setting the mask 60 and the feedback control of the camera, the mask 60 can be set at the region of the smoke 100 appropriately even when the smoke due to fire rises at any position in the monitoring space 50. Further, in the embodiment shown in Fig. 3, the camera 10 can scan the monitoring space

vertically and horizontally, a plurality of light emitting devices 14 or three ones in this embodiment are provided at the opposite side of the monitoring space 50 relative to the camera 10. The synchronizer 16 drives the light emitting devices 14 for lighting in synchronization with the capturing operation of the camera. Thus, when the direction of the camera is changed, backlight illumination is stable.

[0026] Therefore, in the embodiment shown in Fig. 3, multi-level pixel signals in the mask in the state shown in Fig. 4(b) are converted to density signals, and smoke quantity and a quantity of change of the current smoke quantity relative to the previous one are obtained in order to decide fire breaking. Off course, the distance is corrected if necessary according to the detected distance obtained by the distance detector 40.

[0027] In the embodiment shown in Fig. 3, the mask 60 is set relative to the smoke 100, as shown in Fig. 4(b), by scanning rotation of the camera 10. However, the camera 10 may be operated for zooming up, in the state shown in Fig. 4(a), so as to include a portion of the smoke 100 in almost entire area in the mask 60. Further, when the camera 10 can survey all the monitoring space, the mask setting with the feedback control is not necessary, and image processing can be performed to obtain smoke quantity for the mask 60 with the fixed camera.

[0028]

ADVANTAGES OF THE INVENTION

As explained above, according to the invention, because the smoke quantity itself of the smoke rising in the monitoring space due to fire is detected, it is not affected by the size and shape of the monitoring space in contrast to a prior art spot-type smoke detector fixed on the ceiling, and it can detect a fire quickly and correctly.

[0029] Further, because the smoke quantity itself is observed by image processing, smoke due to fire is discriminated positively from fire caused by tobacco or cooking, and erroneous alarm due to smoke not created by fire can be prevented surely. Thus, the reliability is high. Further, as far as the camera captures smoke in the screen, a fire can be decided surely based on the smoke quantity irrespectively of the state of the smoke, for example, when the smoke rises, it flows along the ceiling or it flows along the floor.

[0030] Further, if an image captured by the camera and the result of fire detection are displayed in a monitor in a watching center, an anomalous state of a fire at a remote site can be confirmed without going to the site, and the reliability of the operation of the apparatus can be improved to a large extent.

BRIEF EXPLANATION OF THE DRAWINGS

Fig. 1 is a diagram of a first embodiment of the invention.

Fig. 2 is a graph on a relationship of smoke density plotted against normalized multi-level pixel signal (gradation level) in the embodiment.

Fig. 3 is a diagram of a second embodiment of the invention.

Fig. 4 is a diagram for explaining a control for setting a mask in the second embodiment.

10: High sensitivity camera. 12: Auto-focus device. 14: Light emitter. 16: Synchronizer. 18: Analog-to-digital converter. 20A: First frame memory. 20B: Second frame memory. 22: Smoke area detector. 24: Smoke density calculator. 26A: First smoke area frame memory. 26B: Second smoke area frame memory. 28: Smoke quantity integrator. 30: Amount-of-change integrator. 32: Fire detector. 34: Fire detecting section based on the smoke quantity. 36: Fire detection section based on the amount of change. 38: Subtractor. 40: Distance detector. 50: Monitoring space. 60: Mask. 100: Smoke.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to the smoke sensing device using image processing which processes the picture information of the smoke photoed with the high sensitivity camera, and judges a fire.
[0002]
[Description of the Prior Art]If it is in the ionization smoke detector used for the conventional fire news monitoring instrument, Distributed installation of many ionization smoke detectors is carried out in the ceiling surface of a supervised area, and the scattered light of the light from the light emitting device by the smoke which flowed into the smoke detecting room inside a sensor is received with a photo detector, when the light-receiving output exceeding a predetermined threshold is obtained, it is judged as a fire, and he is trying to send a fire detection signal to a receiver.
[0003]
[Problem(s) to be Solved by the Invention]However, if it is in the conventional ionization smoke detector, the state of the smoke in **** part distributed in warning areas is only detected in spot, Unless a fire occurs directly under a sensor, before flowing into a sensor and exceeding normal concentration after the smoke which went up spreads along a ceiling surface, time will be taken, and there is a problem of moreover being easy to receive the influence by the shape and the size of a supervised area.
[0004]Although what is necessary is for the problem which requires time for fire detection to lower the threshold of fire judgment, and just to raise sensitivity, if sensitivity is raised, it will become easy to cause malfunction with cigarette smoke other than a fire, the steam by cooking, etc. conversely. This invention was made in view of such a conventional problem, and an object of this invention is to provide the smoke sensing device by new image processing which realizes ****, and the early detection of a fire and the prevention from a false report for the volume of smoke outbreak itself by processing the picture of the supervised area caught with the camera.

[0005]
[Means for Solving the Problem]In order to attain this purpose, this invention is constituted as follows. Numerals in an example drawing are shown collectively. This invention is characterized by a smoke sensing device which used image processing comprising the following.
The camera device 10 which picturizes a supervised area and outputs a video signal.
The luminescent device 14 installed in a side which separates the monitor space 50 and faces the camera device 10.
The synchronous system 16 which carries out the luminescence drive of the luminescent device 14 synchronizing with photographing operation of the camera device 10.
The frame memories 20A and 20B which change into a multi-tone pixel signal a picture signal for at least 2 screens photoed with the camera device 10, and memorize it, The emitting smoke field primary detecting element 22 which detects an emitting smoke field from a multi-tone pixel signal for one screen stored in the frame memories 20A and 20B, The smoke-density operation part 24 which calculates smoke density for every pixel based on a multi-tone pixel signal in an emitting smoke field detected in the emitting smoke field primary detecting element 22, and is stored in the emitting smoke field frame memories 26A and 26B, The volume-of-smoke-outbreak integrating part 28 which computes volume of smoke outbreak by integrating with a smoke-density signal for every pixel stored in the emitting smoke field frame memories 26A and 26B, and the fire judgment part 32 which judges a fire based on volume of smoke outbreak computed by the volume-of-smoke-outbreak integrating part 28.

[0006]Instead of the emitting smoke field primary detecting element 22 which decides a picture element region which performs calculation processing of smoke density from a multi-tone pixel signal, The field mask set part 42 which sets up the mask 60 which determines a field appointed beforehand is formed, smoke density for every pixel is calculated based on a multi-tone pixel signal included in a field of a mask set up by the field mask set part 42, and it may be made to store in the emitting smoke field frame memories 26A and 26B.
[0007]The variation integrating part 30 which computes time smoke variation by integrating the subtraction part 38 in quest of [whole pixel] a difference of this smoke-density signal stored in the emitting smoke field frame memories 26A and 26B and the last smoke-density signal is formed, It may be made for the fire judgment part 32 to judge a fire based on volume of smoke outbreak computed by the volume-of-smoke-outbreak integrating part 28, and time smoke variation computed by the variation integrating part 30.
[0008]The distance primary detecting element 40 which detects distance to an emitting smoke field photoed with the camera device 10 is formed, and the smoke-density operation part 24 is calculating smoke density, after amending size of a smoke picture according to distance, and it can perform detection of more exact volume of smoke outbreak.

[0009]
[Function]According to the smoke sensing device using image processing of this invention provided with such composition. Monitor space is photoed with a high sensitivity camera device, the luminescent device formed in the position which faces a camera synchronizing with this photographing operation is driven, and the smoke which it stands on monitor space with a luminescent device, and is reached is photoed where back light illumination is carried out.
[0010]Photoed image processing confirms whether there is any emitting smoke field which smoke projected in the screen first. The check of whether this emitting smoke field exists, The multi-tone pixel signal of a screen is compared last time the multi-tone pixel signal of a screen, and this time, the area whose fall of this multi-tone pixel signal is more than a predetermined level and which has the range, and when a certain pixel number is specifically exceeded, it judges with those with an emitting smoke field, and volume of smoke outbreak is calculated by making this into an emitting smoke area candidate, and it is judged whether it is a fire.
[0011]Thus, since the value equivalent to the volume of smoke outbreak which rises to monitor space by image processing is detectable, compared with the fire judgment depending on the conventional spot smoke density by an ionization smoke detector, a fire can be judged from volume of smoke outbreak promptly and correctly. If it is in the smoke and the steams by cigarette smoke or cooking other than a fire, more exact judgment can be performed by being able to distinguish from there being little volume of smoke outbreak itself clearly compared with a fire, and also seeing the time variation of volume of smoke outbreak.
[0012]
[Example]Drawing 1 is an example lineblock diagram showing the 1st example of this invention. In drawing 1, 10 is a high sensitivity camera, for example, can use a CCD color camera or a color video camera. The high sensitivity camera 10 is provided with the autofocus part 12, and uses what can carry out controls focusing to a photographic subject automatically. The high sensitivity camera 10 is installed in the position which can overlook supervised areas, such as the interior of a room, for example, is installed in the upper part of the wall surface of the room.
[0013]The luminescent device 14 provided with light emitting devices, such as LED, is installed in the position which faces the high sensitivity camera 10. He is trying for the high sensitivity camera 10 and the luminescent device 14 to make the synchronous system 16 perform emission operating for every predetermined picture sampling period synchronizing with photographing operation. For this reason, if the smoke 100 has risen to the monitor space 50 when photoing the monitor space 50 with the high sensitivity camera 10, after the smoke 100 has received the back light illumination by luminescence of the luminescent device 14 in sync with the photographing operation by the synchronous system 16, the high sensitivity camera 10 will photo the picture of the smoke 100.

[0014]The picture signal photoed with the high sensitivity camera 10 is a picture signal of NTSC system, for example.
The luminance signal component of them is changed into the digital signal of multi-tone for every predetermined sampling period by A/D converter 18, and is memorized by turns by the 1st frame memory 20A and the 2nd frame memory 20B.
That is, the image data of two batches which continue in time is stored in the 1st frame memory 20A and the 2nd frame memory 20B as a multi-tone pixel signal for every pixel.
[0015]If the 1st frame memory 20A and the 2nd frame memory 20B are followed, the emitting smoke field primary detecting element 22 is formed. The emitting smoke field primary detecting element 22 detects an emitting smoke field out of the screen information which serves as a processing object now. Detection of this emitting smoke field compares the multi-tone pixel signal for every pixel of the present screen and a whole screen memorized by the 1st and 2nd frame memories 20A and 20B, The field in which the portion which is the pixel more than the predetermined level fell [this multi-tone pixel signal] to last time, and more than this predetermined level fell [the pixel] concentrates, and more than a predetermined pixel number satisfies this condition at a certain time is detected as an emitting smoke field.
[0016]The detection information on the emitting smoke field detected in the emitting smoke field primary detecting element 22 is given to the smoke-density operation part 24. The smoke-density operation part 24 takes out the multi-tone pixel signal included to the emitting smoke field which serves as a processing object now, for example, was detected out of the screen stored in the 1st frame memory 20A, and changes it into a smoke-density signal for every pixel. Drawing 2 is a characteristic figure showing the relation of the smoke density to the multi-tone level used for the operation of the smoke-density operation part 24.
[0017]In drawing 2, the multi-tone level shown on a horizontal axis normalizes with 1.0, expresses the multi-tone level at the time of the smoke density 0 [%/m], and has a relation which smoke density increases with reduction of a multi-tone level. With reference to drawing 1, the concentration signal for every multi-tone pixel signal calculated by the smoke-density operation part 24 is again stored in the 1st emitting smoke field frame memory 26A or the 2nd emitting smoke field frame memory 26B. In this example, since the concentration signal for the last screen and the concentration signal for this screen are needed, the two emitting smoke field frame memories 26A and 26B have been formed.
[0018]If the 1st and 2nd emitting smoke field frame memories 26A and 26B are followed, the volume-of-smoke-outbreak integrating part 28 is formed. The volume-of-smoke-outbreak integrating part 28 computes the volume of smoke outbreak of an emitting smoke field by reading and integrating with the concentration signal included to the emitting smoke field of the present screen stored in either of the 1st and 2nd emitting smoke field frame memories 26A and 26B for every pixel. On the other hand, the variation integrating part 30 which computes the variation of the volume of smoke outbreak of last time and this time is

formed, The variation integrating part 30 computes the time variation of volume of smoke outbreak by finding the integral in quest of the signal which deducted the concentration signal of the screen from the concentration signal of the screen last time this time which is stored in the 1st and 2nd emitting smoke field frame memories 26A and 26B for which it asked with the subtractor 38 to a pixel unit.
[0019]Change of the time volume of smoke outbreak calculated by the volume of smoke outbreak and the variation integrating part 30 which were computed by the volume-of-smoke-outbreak integrating part 28 is given to the fire judgment part 32, and the existence of a fire is judged. The 1st judgment part 34 that judges a fire from volume of smoke outbreak, and the 2nd judgment part 36 that judges a fire from the variation of volume of smoke outbreak are formed in the fire judgment part 32. As fire judgment based on the volume of smoke outbreak in the 1st judgment part 34, the threshold of two size is set up, for example, and if it is beyond the threshold of the larger one, it will be promptly judged as a fire. However, although it is beyond a threshold with smaller volume of smoke outbreak, in being less than the threshold of the larger one, it requires the fire judgment based on the variation of volume of smoke outbreak from the 2nd judgment part 36. If it is in the 2nd judgment part, the existence of a fire is judged from the temporal response of the volume of smoke outbreak exceeding the threshold of the lower one. For example, this volume of smoke outbreak increases to the last volume of smoke outbreak, and if an increase of stock is beyond a predetermined value, it will be judged as a fire.
[0020]Judgment of the fire by the time variation of this volume of smoke outbreak and volume of smoke outbreak predicts change of future volume of smoke outbreak from the change with the past smoke density time, for example only but not only the comparative judgment by a fixed threshold, and it may be made to judge it. If it is in the example of drawing 1, the distance primary detecting element 40 is formed, if it is in this example, the information on the amount of lens movements obtained in the state of the controls focusing to the smoke 100 by the autofocus part 12 of the high sensitivity camera 10 is incorporated, and the distance to the smoke 100 is detected.
[0021]Since the distance information to the smoke 100 detected in the distance primary detecting element 40 is given to the concentration operation part 24 and differs in the size of the detected emitting smoke field according to distance on a screen, it amends this. For example, the detection emitting smoke field on a screen when an emitting smoke field is seen by the reference distance L is S, and suppose that the detection emitting smoke field on a screen when the same emitting smoke field is seen in the twice as many distance 2L as this was S/2. In this case, in order to amend detection emitting smoke field S / 2 on the screen obtained in the distance 2L in the size in the reference distance L, it is referred to as x(S/2) 2, and the amended detection emitting smoke field is asked for the concentration signal for every pixel.
[0022]Since the detection emitting smoke field S is expressed with the pixel number if it is in actual processing, From it being complicated in order to be accompanied by infanticide

processing of a pixel, or interpolation processing of a pixel, carrying out range correction to this pixel unit. What is necessary is to calculate a correction factor from smoke reference distance and detection distance, to send this correction factor to the latter volume-of-smoke-outbreak integrating part 28 and the variation integrating part 32 with a concentration signal, and just to multiply the correction factor according to distance by an integrated result in the smoke-density operation part 24.

[0023]If drawing 3 is an example lineblock diagram showing the 2nd example of this invention and was in this example, the field which performs data processing of smoke density fixed to a photography screen was set up. If it is in the example of drawing 3, the field mask set part 42 is formed instead of the emitting smoke field primary detecting element 22 of drawing 1. The field mask set part 42 sets up the mask 60 of the shape and the size which were beforehand provided in the prescribed position of the photography screen as shown in drawing 4 (a). As this mask 60, since smoke goes up upwards from the bottom by the heat style in case of a fire, it is desirable to set up the slit shape mask 60 which spreads throughout horizontal **** in the center of a screen.

[0024]The field mask set part 42 uses the vertical moving mechanism 46 and the horizontally moving mechanism 48 of the high sensitivity camera 10 which are driven by the camera scanning section 44 at the same time it sets up the mask 60 which decides the field which calculates volume of smoke outbreak to be a screen prescribed position, as shown in drawing 4 (a), Feedback control is performed so that it may come in the center of the smoke 100 in which the mask 60 goes up as shown in drawing 4 (b).

[0025]Even if the smoke by a fire rises in which position of a monitor area by setting out of the mask 60 accompanied by the feedback control of such a camera, the mask 60 can be appropriately set as the portion of the smoke 100. If it is in the example of drawing 3, the high sensitivity camera 10 from vertical and being scanned at the circumference of level to the monitor space 50. If it is in the position of the opposite hand of the monitor space 50 which faces the high sensitivity camera 10 at two or more luminescent devices 14 and this example, the three luminescent devices 14 are formed, and it is the luminescence drive of the luminescent device 14 according to the synchronous system 16 synchronizing with the photographing operation of the high sensitivity camera 10, It can be made to perform back light illumination stable even if direction of the high sensitivity camera 10 changed.

[0026]For this reason, if it is in the example of drawing 3, the multi-tone pixel signal included in the mask 60 by the established state of the mask 60 shown in drawing 4 (b) is changed into a concentration signal, volume of smoke outbreak and the variation of this volume of smoke outbreak to last time are calculated like the example of drawing 1, and it comes to judge a fire. Of course, range correction based on the detection distance from the distance primary detecting element 40 is performed if needed.

[0027]If it is in the example of drawing 3, have made the established state over the smoke 100 of the mask 60 shown in drawing 4 (b) by the rotation scan of the high sensitivity camera 10, but. carrying out zoom-in control of the high sensitivity camera 10 in the state

which shows in drawing 4 (a) -- the mask 60 -- it may be made for the portion of the smoke 100 to go into the whole region mostly Setting out of the mask 60 by the feedback control of a high sensitivity camera is unnecessary, and what is necessary is just to perform image processing which calculates volume of smoke outbreak for the mask 60 side set up by the camera fixed state, when the monitor area whole region can be overlooked from the high sensitivity camera 10.

[0028]

[Effect of the Invention]Since the volume of smoke outbreak of the smoke which rises the monitor space accompanying a fire itself is detected according to this invention as explained above, Influence by the size or shape of a supervised area cannot be received like the ionization smoke detector of a spot type installed in the conventional ceiling surface, but a fire can be judged promptly and correctly from volume of smoke outbreak.

[0029]Since the volume of smoke outbreak itself is seen by image processing, the smoke of a cigarette, the smoke accompanying cooking, and the smoke by a fire can be distinguished clearly, the false report by smoke other than a fire can be avoided certainly, and high reliability is acquired. If it can catch on the screen of a camera, even if smoke has risen, it is flowing along the ceiling surface and it is flowing along the floor line, a fire can be certainly judged from volume of smoke outbreak not related in the state of the smoke.

[0030]By carrying out a monitor display to the monitoring center side with the result of fire judgment of the taken image caught with the camera, the abnormal condition of the spot remotely judged to be a fire can be checked without going to the spot, and the reliability on employment of a device can be improved substantially.

[Translation done.]

Abstract of Ref. I
* Machine trans. doc. 198397

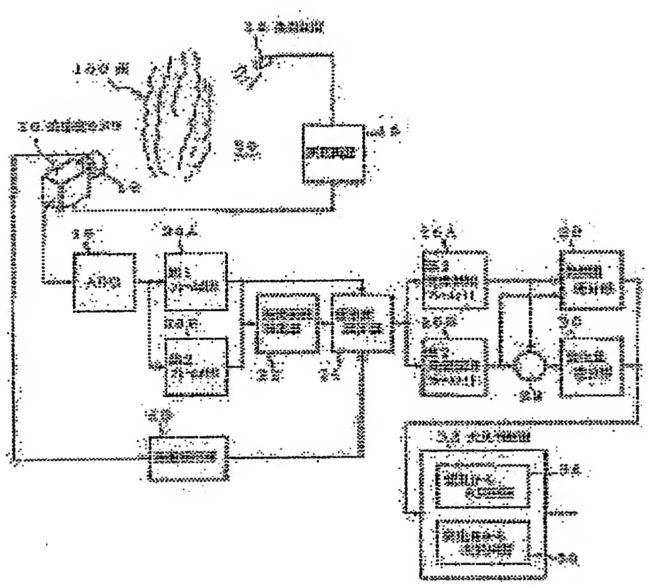
SMOKE DETECTOR USING IMAGE PROCESSING

Publication number: JP5020563 (A)
Publication date: 1993-01-29
Inventor(s): ISHII HIROMITSU; ONO TAKASHI; WATANABE KIYOSHI
Applicant(s): HOCHIKI CO; ISHII HIROMITSU
Classification:
- international: ***G01N21/17; G08B17/10; G08B17/103; H04N7/18;*** **G01N21/17; G08B17/10; G08B17/103; H04N7/18;** (IPC1-7): G01N21/17; G08B17/10; H04N7/18
- European:
Application number: JP19910175700 19910717
Priority number(s): JP19910175700 19910717

Also published as:
JP3001676 (B2)

Abstract of **JP 5020563 (A)**

PURPOSE:To perform the fire judgment to make compatible the early discovery and the erroneous information prevention of the fire by grasping the smoking quantity by processing the image of the monitoring area of the smoke photographed by a high sensitivity camera. CONSTITUTION:A light emitting device 14 to synchronize the photographing action of a camera device 10 and to be provided at the facing position is light- emitted and driven, the photographed image signal is converted to a multi- gradation picture element signal, stored into frame memories 20A and 20B, the smoking area is detected from the multi-gradation picture element signal of one screen stored in the frame memories 20A and 20B, and by operating and integrating the smoke concentration for each picture element based on the multi-gradation picture element signal in the smoking area, the smoking quantity is calculated,; and the fire is judged from the smoking quantity. From the change quantity of the previous smoking quantity and the present smoking quantity, the fire may be judged.



Ref. I

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（A）　(11)特許出願公開番号

特開平5－20563

(43)公開日　平成５年(1993)１月29日

(51)Int.Cl.⁵	識別記号	庁内整理番号	F I	技術表示箇所
G 0 8 B　17/10	D	7319－5G		
G 0 1 N　21/17	A	7370－2 J		
H 0 4 N　7/18	K	8626－5C		
	D	8626－5C		

審査請求　未請求　請求項の数４(全　８　頁)

(21)出願番号　特願平3－175700

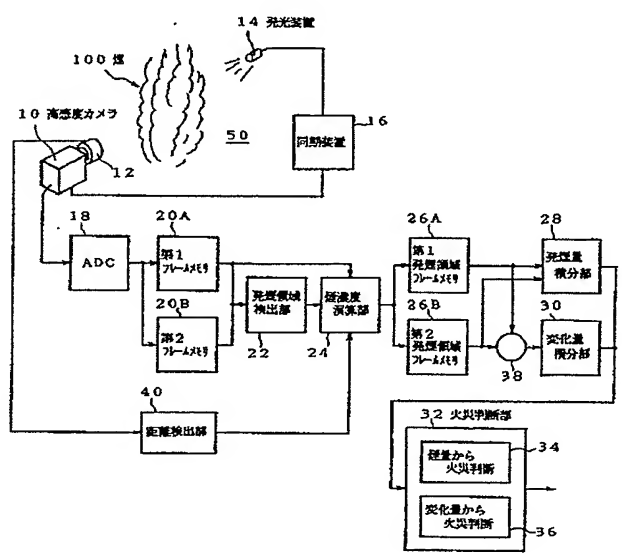
(22)出願日　平成３年(1991)７月17日

(71)出願人　000003403
ホーチキ株式会社
東京都品川区上大崎２丁目10番43号
(71)出願人　591009738
石井　弘允
千葉県千葉市美浜区高洲３丁目５番２棟801号
(72)発明者　石井　弘允
千葉県千葉市高洲３丁目５番２棟801号
(72)発明者　小野　隆
千葉県柏市大室1499番地31
(74)代理人　弁理士　竹内　進　（外１名）

最終頁に続く

(54)【発明の名称】　画像処理を用いた煙検出装置

(57)【要約】
【目的】高感度カメラで撮影した煙の画像情報を処理して火災を判断する画像処理を用いた煙検出装置に関し、監視区域の画像を処理することによって発煙量そのものを把え、火災の早期発見と誤報防止を両立した火災判断を可能にすることを目的とする。
【構成】カメラ装置の撮影動作に同期して向かい合う位置に設けた発光装置を発光駆動し、撮影した画像信号を多階調画素信号に変換してフレームメモリに格納し、フレームメモリに格納された１画面分の多階調画素信号から発煙領域を検出し、発煙領域内の多階調画素信号に基づいて各画素毎の煙濃度を演算して積分することにより発煙量を算出し、この発煙量から火災を判断する。また前回の発煙量と今回の発煙量の変化量から火災を判断してもよい。



1

【特許請求の範囲】

【請求項１】監視区域を撮像して映像信号を出力するカメラ装置と、

監視空間を隔てて前記カメラ装置に向い合う側に設置された発光装置と、

前記カメラ装置の撮影動作に同期して前記発光装置を発光駆動する同期装置と、

前記カメラ装置で撮影された少なくとも２画面分の画像信号を多階調画素信号に変換して記憶するフレームメモリと、

該フレームメモリに格納された１画面分の多階調画素信号から発煙領域を検出する発煙領域検出部と、

該発煙領域検出部で検出された発煙領域内の多階調画素信号に基づいて各画素毎の煙濃度を演算して発煙領域フレームメモリに格納する煙濃度演算部と、

前記発煙領域フレームメモリに格納された画素毎の煙濃度信号を積分して発煙量を算出する発煙量積分部と、

該発煙量積分部で算出した発煙量に基づいて火災を判断する火災判断部と、

を備えたことを特徴とする画像処理を用いた煙検出装置。

【請求項２】監視区域を撮像して映像信号を出力するカメラ装置と、

監視空間を隔てて前記カメラ手段に向い合う側に設置された発光装置と、

前記カメラ装置の撮影動作に同期して前記発光装置を発光駆動する同期装置と、

前記カメラ装置で撮影された少なくとも２画面分の画像信号を多階調画素信号に変換して記憶するフレームメモリと、

該フレームメモリに格納された画面内に発煙量の検出処理を行なう予め定めた領域を決めるマスクを設定する領域マスク設定部と、

該領域マスク設定部で設定されたマスクの領域内に含まれる多階調画素信号に基づいて各画素毎の煙濃度を演算して発煙領域フレームメモリに格納する煙濃度演算部と、

前記発煙領域フレームメモリに格納された画素毎の煙濃度信号を積分して発煙量を算出する発煙量積分部と、

該発煙量積分部で算出した発煙量に基づいて火災を判断する火災判断部と、

を備えたことを特徴とする画像処理を用いた煙検出装置。

【請求項３】請求項１又は請求項２記載の画像処理を用いた煙検出装置に於いて、

更に、前記発煙領域フレームメモリに格納された今回の煙濃度信号と前回の煙濃度信号との差を画素毎に求めて積分することにより時間的な煙変化量を算出する変化量積分部を設け、前記火災判断部は前記発煙量積分部で算出した発煙量と前記変化量積分部で算出した時間的な変化量に基づいて火災を判断することを特徴とする画像処理を用いた煙検出装置。

2

【請求項４】請求項１又は請求項２記載の画像処理を用いた煙検出装置に於いて、

更に、前記カメラ装置で撮影した発煙領域までの距離を検出する距離検出部を設け、前記濃度演算部は距離に応じて煙画像のサイズを補正した後に煙濃度を演算することを特徴とする画像処理を用いた煙検出装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、高感度カメラで撮影した煙の画像情報を処理して火災を判断する画像処理を用いた煙検出装置に関する。

【０００２】

【従来の技術】従来の火災報監視装置に使用される煙感知器にあっては、監視区域の天井面に多数の煙感知器を分散設置し、感知器内部の検煙室に流入した煙による発光素子からの光の散乱光を受光素子で受光し、所定の閾値を越える受光出力が得られた時に火災と判断し、火災検出信号を受信機に送るようにしている。

【０００３】

【発明が解決しようとする課題】しかしながら、従来の煙感知器にあっては、警戒区域の中に分散した極く一部における煙の状態をスポット的に検出しているにすぎず、感知器の直下で火災が起きない限り、上昇した煙が天井面に沿って広がった後に感知器に流入して規定濃度を越えるまでには時間がかかり、しかも監視区域の形状や大きさによる影響を受け易いという問題がある。

【０００４】火災検出に時間がかかる問題は火災判断の閾値を下げて感度を上げればよいが、感度を上げると逆に火災以外のタバコの煙や調理による水蒸気等で誤動作を起し易くなる。本発明は、このような従来の問題点に鑑みてなされたもので、カメラで捕えた監視区域の画像を処理することによって発煙量そのものを把え、火災の早期発見と誤報防止を実現する新規な画像処理による煙検出装置を提供することを目的とする。

【０００５】

【課題を解決するための手段】この目的を達成するため本発明は次のように構成する。尚、実施例図面中の符号を併せて示す。本発明の画像処理を用いた煙検出装置は、監視区域を撮像して映像信号を出力するカメラ装置１０と、監視空間５０を隔ててカメラ装置１０に向い合う側に設置された発光装置１４と、カメラ装置１０の撮影動作に同期して発光装置１４を発光駆動する同期装置１６と、カメラ装置１０で撮影された少なくとも２画面分の画像信号を多階調画素信号に変換して記憶するフレームメモリ２０Ａ，２０Ｂと、フレームメモリ２０Ａ，２０Ｂに格納された１画面分の多階調画素信号から発煙領域を検出する発煙領域検出部２２と、発煙領域検出部２２で検出された発煙領域内の多階調画素信号に基づい

て各画素毎の煙濃度を演算して発煙領域フレームメモリ２６Ａ，２６Ｂに格納する煙濃度演算部２４と、発煙領域フレームメモリ２６Ａ，２６Ｂに格納された画素毎の煙濃度信号を積分して発煙量を算出する発煙量積分部２８と、発煙量積分部２８で算出した発煙量に基づいて火災を判断する火災判断部３２とを設けたことを特徴とする。

【０００６】また多階調画素信号から煙濃度の算出処理を行う画素領域を決める発煙領域検出部２２の代わりに、予め定めた領域を決めるマスク６０を設定する領域マスク設定部４２を設け、領域マスク設定部４２で設定されたマスクの領域内に含まれる多階調画素信号に基づいて各画素毎の煙濃度を演算して発煙領域フレームメモリ２６Ａ，２６Ｂに格納するようにしてもよい。

【０００７】また発煙領域フレームメモリ２６Ａ，２６Ｂに格納された今回の煙濃度信号と前回の煙濃度信号との差を減算部３８で画素毎に求めて積分することにより時間的な煙変化量を算出する変化量積分部３０を設け、火災判断部３２は発煙量積分部２８で算出した発煙量と変化量積分部３０で算出した時間的な煙変化量に基づいて火災を判断するようにしてもよい。

【０００８】更に、カメラ装置１０で撮影した発煙領域までの距離を検出する距離検出部４０を設け、煙濃度演算部２４は距離に応じて煙画像のサイズを補正した後に煙濃度を演算することで、より正確な発煙量の検出ができる。

【０００９】

【作用】このような構成を備えた本発明の画像処理を用いた煙検出装置によれば、高感度カメラ装置により監視空間を撮影し、この撮影動作に同期してカメラに向かい合う位置に設けている発光装置を駆動し、発光装置により監視空間に立ち登る煙をバックライト照明した状態で撮影する。

【００１０】撮影した画像処理は、まず画面内に煙が映し出された発煙領域があるか否かチェックする。この発煙領域が存在するか否かのチェックは、前回画面の多階調画素信号と今回画面の多階調画素信号とを比較し、今回の多階調画素信号の低下が所定レベル以上で且つその範囲がある面積、具体的にはある画素数を越えた時に発煙領域ありと判定し、これを発煙領域候補として発煙量を求め、火災か否か判断する。

【００１１】このように画像処理によって監視空間に立ち上る発煙量に相当する値が検出できるため、煙感知器による従来のスポット的な煙濃度に依存した火災判断に比べ、迅速且つ正確に発煙量から火災を判断することができる。また火災以外のタバコの煙や調理による煙や水蒸気にあっては、火災に比べて発煙量そのものが少ないことから明確に区別でき、更に発煙量の時間的な変化量をみることでより正確な判断ができる。

【００１２】

【実施例】図１は本発明の第１実施例を示した実施例構成図である。図１において、１０は高感度カメラであり、例えばＣＣＤカラーカメラあるいはカラービデオカメラ等を使用することができる。また高感度カメラ１０はオートフォーカス部１２を備え、自動的に被写体に対し合焦制御できるものを使用する。高感度カメラ１０は室内等の監視区域を見渡せる位置に設置されており、例えば部屋の壁面の上部に設置されている。

【００１３】高感度カメラ１０に向かい合う位置にはＬＥＤ等の発光素子を備えた発光装置１４が設置されている。高感度カメラ１０及び発光装置１４は同期装置１６により所定の画像サンプリング周期毎に撮影動作に同期して発光動作を行わせるようにしている。このため、高感度カメラ１０で監視空間５０を撮影する際には監視空間５０に煙１００が立ち上っていれば同期装置１６による撮影動作に同期した発光装置１４の発光によるバックライト照明を煙１００が受けた状態で高感度カメラ１０は煙１００の画像を撮影する。

【００１４】高感度カメラ１０で撮影された画像信号は、例えばＮＴＳＣ方式の画像信号であり、そのうちの輝度信号成分がＡＤ変換器１８で所定サンプリング周期毎に多階調のデジタル信号に変換され、第１フレームメモリ２０Ａと第２フレームメモリ２０Ｂに交互に記憶される。即ち、第１フレームメモリ２０Ａ、第２フレームメモリ２０Ｂには時間的に連続する２回分の画像データが画素毎の多階調画素信号として格納される。

【００１５】第１フレームメモリ２０Ａ及び第２フレームメモリ２０Ｂに続いては発煙領域検出部２２が設けられる。発煙領域検出部２２は現在処理対象となっている画面情報の中から発煙領域を検出する。この発煙領域の検出は第１及び第２フレームメモリ２０Ａ，２０Ｂに記憶された現在画面と全体画面の各画素毎の多階調画素信号を比較し、前回に対し今回の多階調画素信号が所定レベル以上低下し、この所定レベル以上低下した画素の部分が集中して所定画素数以上あるときにこの条件を満足する領域を発煙領域として検出する。

【００１６】発煙領域検出部２２で検出された発煙領域の検出情報は煙濃度演算部２４に与えられる。煙濃度演算部２４は現在処理対象となっている、例えば第１フレームメモリ２０Ａに格納された画面の中から検出された発煙領域に含まれる多階調画素信号を取り出して画素毎に煙濃度信号に変換する。図２は煙濃度演算部２４の演算に使用される多階調レベルに対する煙濃度の関係を示した特性図である。

【００１７】図２において、横軸に示す多階調レベルは煙濃度０［％／ｍ］のときの多階調レベルを１．０と正規化して表わしており、多階調レベルの減少に伴って煙濃度が増加する関係にある。再び図１を参照するに、煙濃度演算部２４で演算された多階調画素信号毎の濃度信号は第１発煙領域フレームメモリ２６Ａまたは第２発煙

領域フレームメモリ２６Ｂに格納される。この実施例では前回の画面分の濃度信号と今回の画面分の濃度信号を必要とすることから２つの発煙領域フレームメモリ２６Ａ，２６Ｂを設けている。

【００１８】第１及び第２の発煙領域フレームメモリ２６Ａ，２６Ｂに続いては発煙量積分部２８が設けられる。発煙量積分部２８は第１及び第２発煙領域フレームメモリ２６Ａ，２６Ｂのいずれか一方に格納された現在画面の発煙領域に含まれる濃度信号を画素毎に読み出して積分することで発煙領域の発煙量を算出する。一方、前回と今回の発煙量の変化量を算出する変化量積分部３０が設けられており、変化量積分部３０は減算器３８で求めた第１及び第２発煙領域フレームメモリ２６Ａ，２６Ｂに格納されている今回画面の濃度信号から前回画面の濃度信号を差し引いた信号を画素単位に求めて積分することで発煙量の時間的な変化量を算出する。

【００１９】発煙量積分部２８で算出された発煙量及び変化量積分部３０で演算された時間的な発煙量の変化は火災判断部３２に与えられて火災の有無が判断される。火災判断部３２には発煙量から火災を判断する第１判断部３４と発煙量の変化量から火災を判断する第２判断部３６が設けられる。第１判断部３４における発煙量に基づく火災判断としては、例えば大小２つの閾値を設定し、大きい方の閾値以上であれば直ちに火災と判断する。しかし、発煙量が小さい方の閾値以上であるが大きい方の閾値未満である場合には第２判断部３６に対し発煙量の変化量に基づく火災判断を要求する。第２判断部にあっては、低い方の閾値を越える発煙量の時間的変化から火災の有無を判断する。例えば前回の発煙量に対し今回の発煙量が増加し且つ増加量が所定値以上であれば火災と判断する。

【００２０】この発煙量と発煙量の時間的な変化量による火災の判断は固定的な閾値による比較判断のみならず、例えば過去の煙量の時間的な変化から将来の発煙量の変化を予測して判断するようにしてもよい。更に、図１の実施例にあっては距離検出部４０が設けられており、この実施例にあっては高感度カメラ１０のオートフォーカス部１２による煙１００に対する合焦制御状態で得られるレンズ移動量の情報を取り込んで煙１００までの距離を検出する。

【００２１】距離検出部４０で検出された煙１００までの距離情報は濃度演算部２４に与えられ、検出された発煙領域のサイズが画面上で距離に応じて異なることから、これを補正する。例えば基準距離Ｌで発煙領域をみたときの画面上での検出発煙領域がＳであり、同じ発煙領域を２倍の距離２Ｌでみたときの画面上での検出発煙領域がＳ／２であったとする。この場合には、距離２Ｌで得られた画面上の検出発煙領域Ｓ／２を基準距離Ｌでのサイズに補正するため、（Ｓ／２）×２とし、補正した検出発煙領域に画素毎の濃度信号を求める。

【００２２】実際の処理にあっては、検出発煙領域Ｓは画素数で表わされているため、この画素単位に距離補正を行うことは画素の間引き処理や画素の補間処理を伴うためには繁雑であることから、煙濃度演算部２４では煙基準距離と検出距離から補正係数を求め、この補正係数を濃度信号と共に後段の発煙量積分部２８及び変化量積分部３２に送り、積分結果に距離に応じた補正係数を掛け合わせればよい。

【００２３】図３は本発明の第２実施例を示した実施例構成図であり、この実施例にあっては撮影画面に対し固定的に煙濃度の演算処理を行う領域を設定するようにしたことを特徴とする。図３の実施例にあっては、図１の発煙領域検出部２２の代わりに領域マスク設定部４２が設けられている。領域マスク設定部４２は図４（ａ）に示すように撮影画面の所定位置に予め定めた形状と大きさのマスク６０を設定する。このマスク６０としては、煙が火災時の熱気流によって下から上に上昇することから画面の中央で横ほぼ全域に広がるようなスリット状のマスク６０を設定することが望ましい。

【００２４】領域マスク設定部４２は図４（ａ）に示すように画面所定位置に発煙量の演算を行う領域を決めるマスク６０を設定すると同時にカメラ走査部４４で駆動される高感度カメラ１０の垂直回動機構４６及び水平回動機構４８を使用して、図４（ｂ）に示すようにマスク６０が上昇する煙１００の中央にくるようにフィードバック制御を行う。

【００２５】このようなカメラのフィードバック制御を伴うマスク６０の設定により監視領域のどの位置で火災による煙が立ち上っても適切に煙１００の部分にマスク６０を設定することができる。更に図３の実施例にあっては、監視空間５０に対し高感度カメラ１０が垂直及び水平回りに走査されることから、高感度カメラ１０に向かい合う監視空間５０の反対側の位置に複数の発光装置１４、この実施例にあっては３つの発光装置１４を設け、高感度カメラ１０の撮影動作に同期して同期装置１６による発光装置１４の発光駆動で、高感度カメラ１０の向きが変わっても安定したバックライト照明ができるようにしている。

【００２６】このため図３の実施例にあっては、図４（ｂ）に示すマスク６０の設定状態でマスク６０に含まれる多階調画素信号を濃度信号に変換し、図１の実施例と同様にして発煙量及び前回に対する今回の発煙量の変化量を求め、火災を判断するようになる。勿論、必要に応じて距離検出部４０からの検出距離に基づいた距離補正を行う。

【００２７】尚、図３の実施例にあっては、高感度カメラ１０の回動走査により図４（ｂ）に示すマスク６０の煙１００に対する設定状態を作り出しているが、図４（ａ）に示す状態で高感度カメラ１０をズームアップ制御し、マスク６０のほぼ全域に煙１００の部分が入るよ

うにしてもよい。更に高感度カメラ１０から監視領域全域が見渡せる場合には、高感度カメラのフィードバック制御によるマスク６０の設定は不要で、カメラ固定状態で設定したマスク６０側を対象に発煙量を求める画像処理を行えばよい。

【００２８】

【発明の効果】以上説明してきたように、本発明によれば、火災に伴う監視空間を立ち上る煙の発煙量そのものを検出しているため、従来の天井面に設置されるスポット型の煙感知器のように監視区域の大きさや形状による影響を受けず、発煙量から迅速且つ正確に火災を判断することができる。

【００２９】また、画像処理により発煙量そのものを見ているため、煙草の煙や調理に伴う煙と火災による煙を明確に区別することができ、火災以外の煙による誤報を確実に回避でき、高い信頼性が得られる。更に、カメラの画面で捕えることができれば、煙が立ち上っていても天井面に沿って流れていても床面に沿って流れていても、その煙の状態に関係なく確実に発煙量から火災を判断できる。

【００３０】更にカメラで捕えた撮影画像を火災判断の結果と共に監視センタ側にモニタ表示することで、現場に出向くことなく遠隔的に火災と判断された現場の異常状態を確認でき、装置の運用上の信頼性を大幅に向上できる。

【図面の簡単な説明】

【図１】本発明の第１実施例を示した実施例構成図

【図２】図１の実施例における多階調画素信号と煙濃度との対応関係を示した特性図　＊

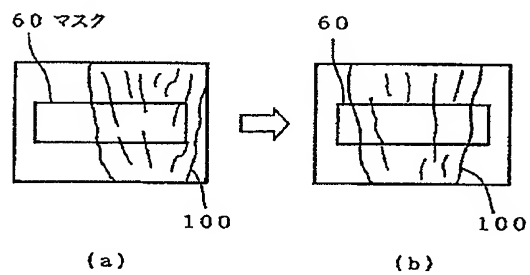
＊【図３】本発明の第２実施例を示した説明図

【図４】図３の実施例におけるマスクの設定制御を示した説明図

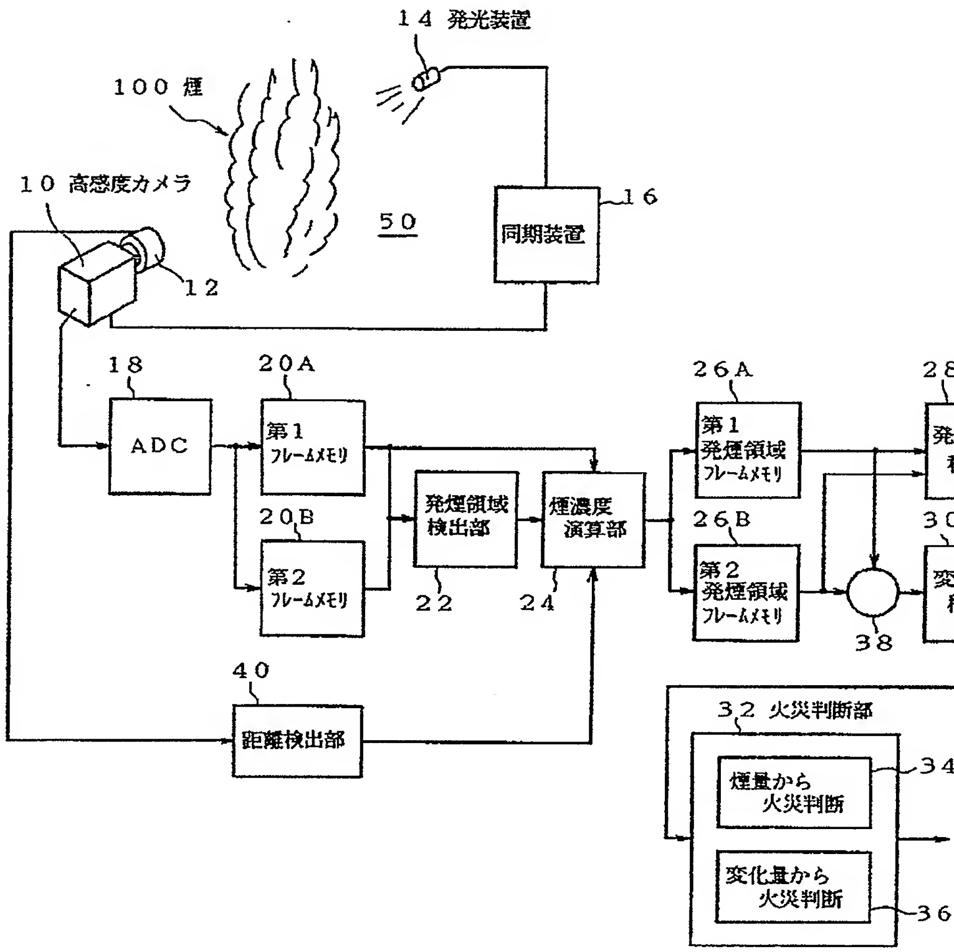
【符号の説明】

１０：高感度カメラ（カメラ装置）
１２：オートフォーカス部
１４：発光装置
１６：同期装置
１８：ＡＤ変換器
２０Ａ：第１フレームメモリ
２０Ｂ：第２フレームメモリ
２２：発煙領域検出部
２４：煙濃度演算部
２６Ａ：第１発煙領域フレームメモリ
２６Ｂ：第２発煙領域フレームメモリ
２８：発煙量積分部
３０：変化量積分部
３２：火災判断部
３４：第１判断部
３６：第２判断部
３８：減算器
４０：距離検出部
４２：領域マスク設定部
４４：カメラ走査部
４６：垂直回動機構
４８：水平回動機構
５０：監視空間
６０：マスク
１００：煙

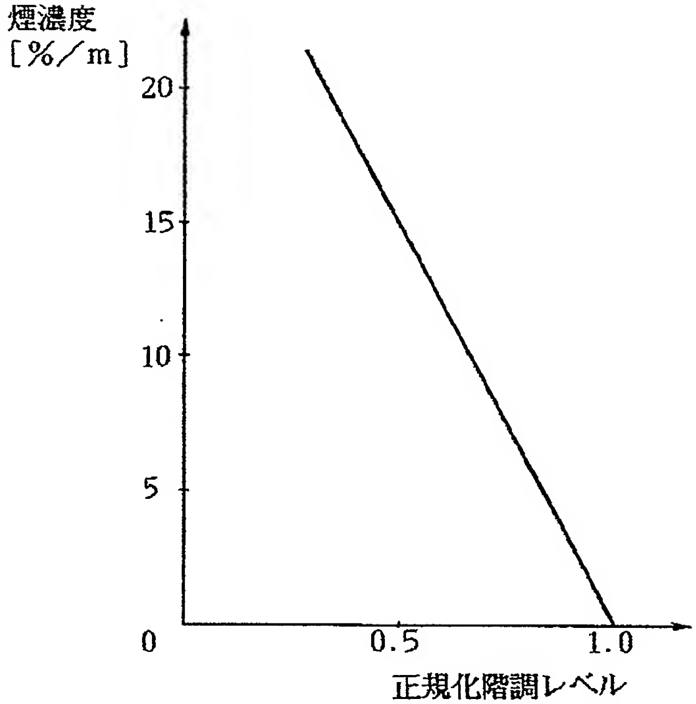
【図４】



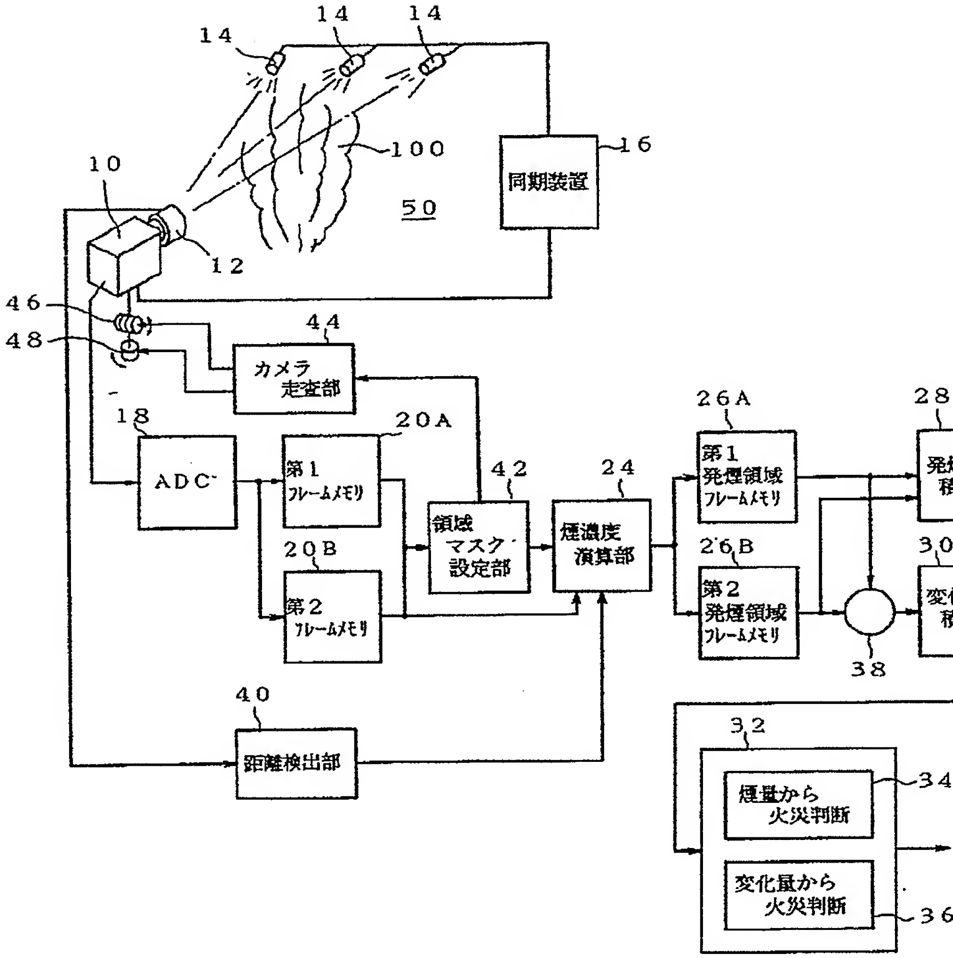
【図１】


１４ 発光装置
１００ 煙
１０ 高感度カメラ
５０
同期装置
１６
１２
１８
ADC
２０A
第１
フレームメモリ
２０B
第２
フレームメモリ
発煙領域
検出部
２２
煙濃度
演算部
２４
２６A
第１
発煙領域
フレームメモリ
２６B
第２
発煙領域
フレームメモリ
２８
発煙量
積分部
３０
変化量
積分部
３８
４０
距離検出部
３２ 火災判断部
煙量から
火災判断
３４
変化量から
火災判断
３６

【図２】



【図３】



フロントページの続き

(72)発明者　渡辺　洌
東京都品川区上大崎２丁目10番43号　ホーチキ株式会社内